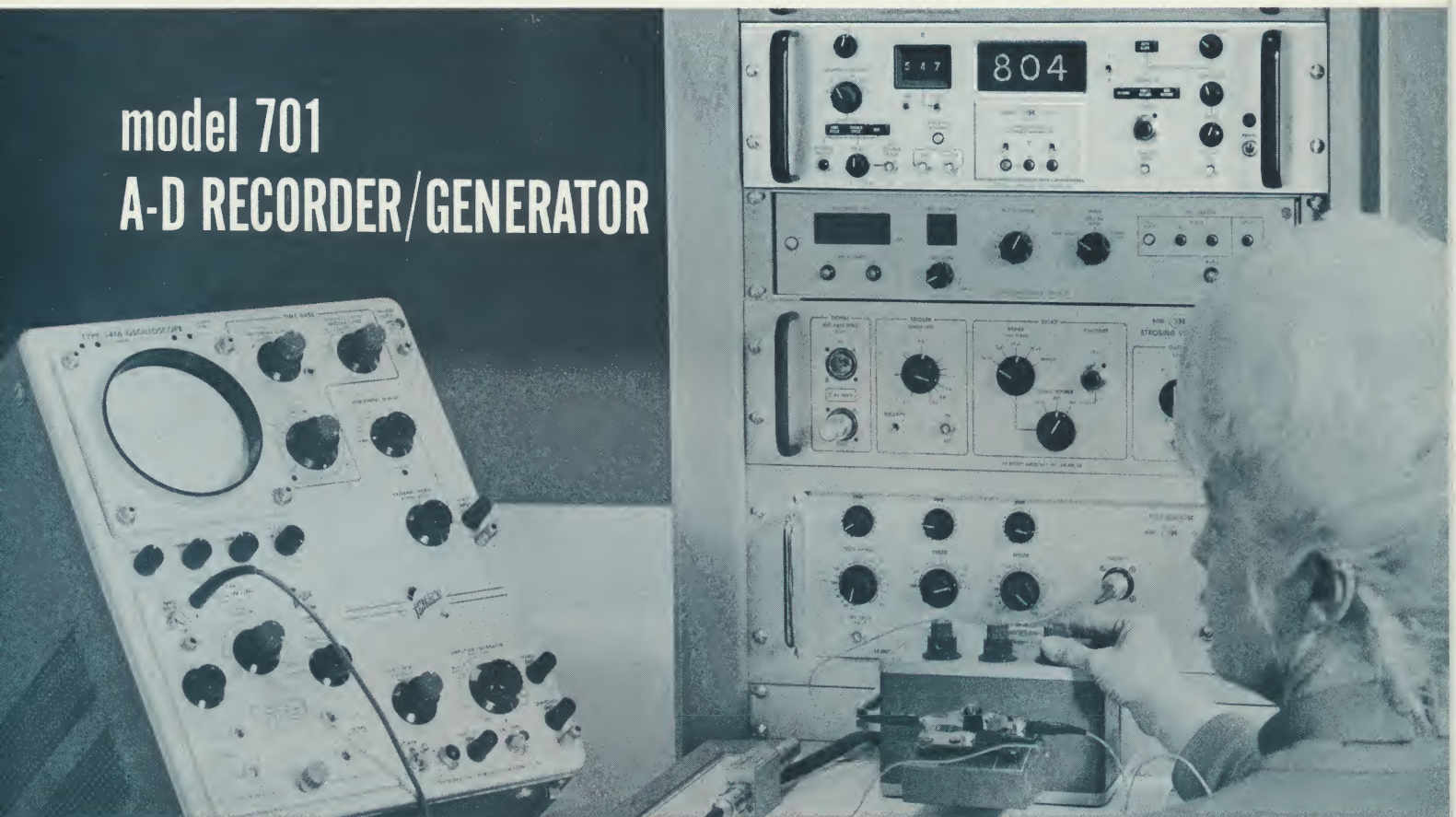




technical data

model 701 A-D RECORDER/GENERATOR



functions

AS A HI-SPEED DIGITAL DATA-LOGGING SYSTEM ■ AS A SAMPLE, DIGITIZE, & HOLD MEMORY WITH PROGRAMMED LIMITS COMPARISON ■ AS AN ANALOG FUNCTION DIGITIZE, RECORD, & PLAYBACK SYSTEM ■ AS A SINGLE-EVENT RECORDER WITH TIME BASE EXPANSION ■ AS AN ARBITRARY FUNCTION GENERATOR ■ AS A PATTERN RECOGNITION COMPUTER



E-H RESEARCH LABORATORIES, INC.

model 701

A-D RECORDER/GENERATOR



The E-H Model 701 A-D Recorder/Generator is a digital data storage system which is arranged to allow two fundamental modes of operation:

(1) the memory is organized to accept 3-digit BCD voltage-ordinate information for each of 1000 time-slots as in Fig. 1. In conjunction with self-contained clock, A/D converter in WRITE mode, and D/A converter in READ mode (Fig. 2), the instrument will digitize and record a single-event transient voltage $v=f(t)$, store it indefinitely, and replay it as required in either digital or analog form, single-shot or iterated, on the original time-base or at any time rate within its range of one segment per second to 10^5 segments per second.

(2) the memory may be used as a 1000-word, 12-bit-per-word random-access storage system, without reference to the voltage-vs-time mode, with 3-digit BCD word address on the x-axis.

Fig. 2 diagrams the essential elements involved in the information or y-channel, which is the voltage-ordinate channel in Mode 1 above, or the word-channel in Mode 2. There are four possible sequences through the instrument:

- BCD input directly into the input register, BCD readout
- Analog input converted to BCD form by the A/D converter for storage, BCD readout direct from the register
- BCD input to the memory, with analog synthesis via the D/A block in the readout path
- Analog input digitized, recorded, and played back in analog reconstruction

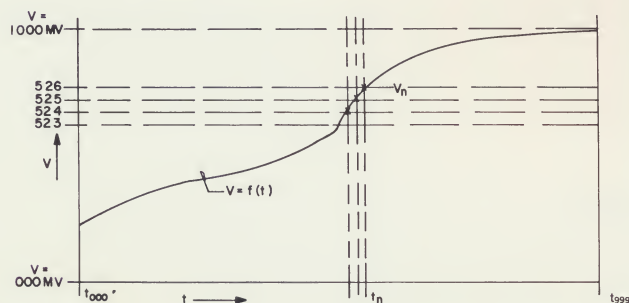


Fig. 1. Organization of the Model 701 Memory: A 1000 x 1000 grid accepts 3-digit voltage ordinate information at each of 1000 time-slots for high-resolution transient recording.

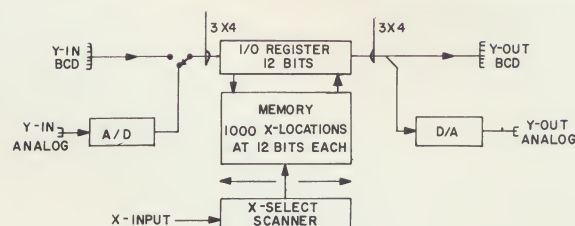


Fig. 2. Y-channel elements, showing four possible paths for the record/playback process.

Regardless of the sequence selected, each discrete WRITE or READ operation handles 12 bits of y-information simultaneously at one of 1000 x-locations. Note that there is no necessity for the 12 bits to represent a 3-digit decimal number: the word recorded may represent any information that may be coded into 12 binary bits.

Recorded information may be stored indefinitely and read out an unlimited number of times without degradation: the 701 uses magnetic core bit-storage with re-record at readout. Temporary power loss (or turning the instrument off) does not affect the memory. The only way to lose or change a recording is to write in new information in place of the old.

X-AXIS SCANNING MODES

The x-select scanner, which determines the time-slot t_n connected to the I/O register for read/write operations, is controlled by a BCD input which may be selected from three possible sources:

- a time-base generator, whose clock rate is set by panel controls
- a three-digit thumbwheel switch located on the front panel
- direct BCD input via a rear-panel connector (x-input on the block diagram), allowing random access under external control

In TRIGGERED CYCLE operation the scan moves sequentially at the internal clock rate from t_{000} to t_{999} (Fig. 1), on command from a MANUAL TRIGGER or external sync pulse.

In CONTINUOUS CYCLE operation the scan sweeps from t_{000} to t_{999} then resets to t_{000} and repeats the scan indefinitely.

In SEQUENTIAL operation each trigger pulse advances the scan one segment, where it remains until the next trigger occurs, allowing use of an external clock or manual stepping for point-by-point recording or manual level setting.

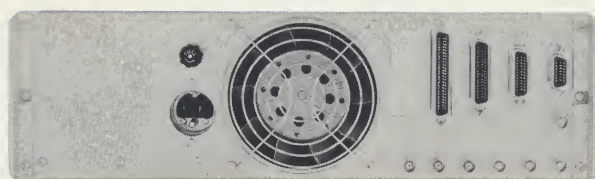


Fig. 3. Rear view, Model 701 A-D RECORDER/GENERATOR

FUNCTIONAL MODES

The instrument is in playback mode if neither of the RECORD buttons is in. The NON-RECORD button merely clears the detent on the switch deck.

In RECORD operation the information present at the y-input terminals of the input register is put into the memory at the location of the x-select scanner. Recording occurs on each clock or trigger pulse.

In SINGLE POINT RECORD the instrument is in playback mode except for the single ordinate selected by either the panel thumbwheels or the x-input lines. This point may be changed without disturbing any other ordinate, allowing the operator to trim up any recorded function point-by-point while observing the effect on a continuous display.

AUXILIARY FEATURES

Limits comparison: When the input register receives 3-digit ordinate information for recording, the ordinate is compared to upper and lower limits supplied from external sources. The limits programs are sampled at time of digitizing and held in registers until the next comparison is to be made: this sample-and-hold feature accommodates limits sources which fluctuate.

Panel indication of the comparison is given by LO/GO/HI lamps, and the information is delivered to a rear-panel connector for systems use.

Marker: In generating a repetitive function it is sometimes desirable to have positive indication of the location of specific ordinates on the time base. A marker generator is included in the 701 which adds a variable-amplitude spike to the analog output whenever the x-select scanner reaches any desired segment t_{000} to t_{1000} . The marker appears at the time-slot selected by either the thumbwheels or the external x-input, whichever is programmed into the system.

Glow-Tube Display: The 3-digit display in the center of the panel indicates continuously the location of the x-select scanner or the y-output amplitude, depending on the position of the adjacent toggle switch. An additional selector on the limits-comparison allows display of either the x or y limit program.

Offset: A ten-turn potentiometer with high-resolution dial allows insertion of precise DC voltages into the analog y-input over the entire range 0 to +1 volt. This feature makes it possible to do point-by-point construction and recording of any desired function from computed tables, without the need for an external voltage source.

PROGRAMMING

A number of control lines are brought out to a rear-panel connector (labeled EXT PROGRAM on the block diagram) to allow remote control of 701 functions. Activation of these lines overrides panel controls, for programming of:

- RECORD/NON-RECORD/SINGLE-PT. RECORD function selection
- TRIGGERED CYCLE/CONTINUOUS CYCLE/SEQUENTIAL mode selection
- STOP: go to 000/xxx digit switch/xxx external x-input, x-scan position
- STAIR-STEP/AUTO-SLOPE synthesis mode selection

Additional control inputs are:

- Switch y-input register from A/D output to BCD y-input lines
- Inhibit Δx /override
- Inhibit y-input/override
- Hold limits/Hold limits comparison information
- Switch x-select from digit switch input to BCD x-input

There are also control outputs which inform the controlling system of the operations in progress, when orders have been carried out, when all is clear to proceed to the next operation, etc.

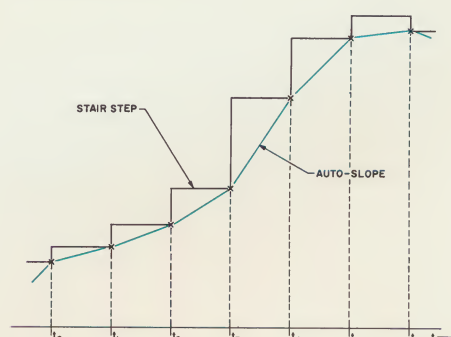
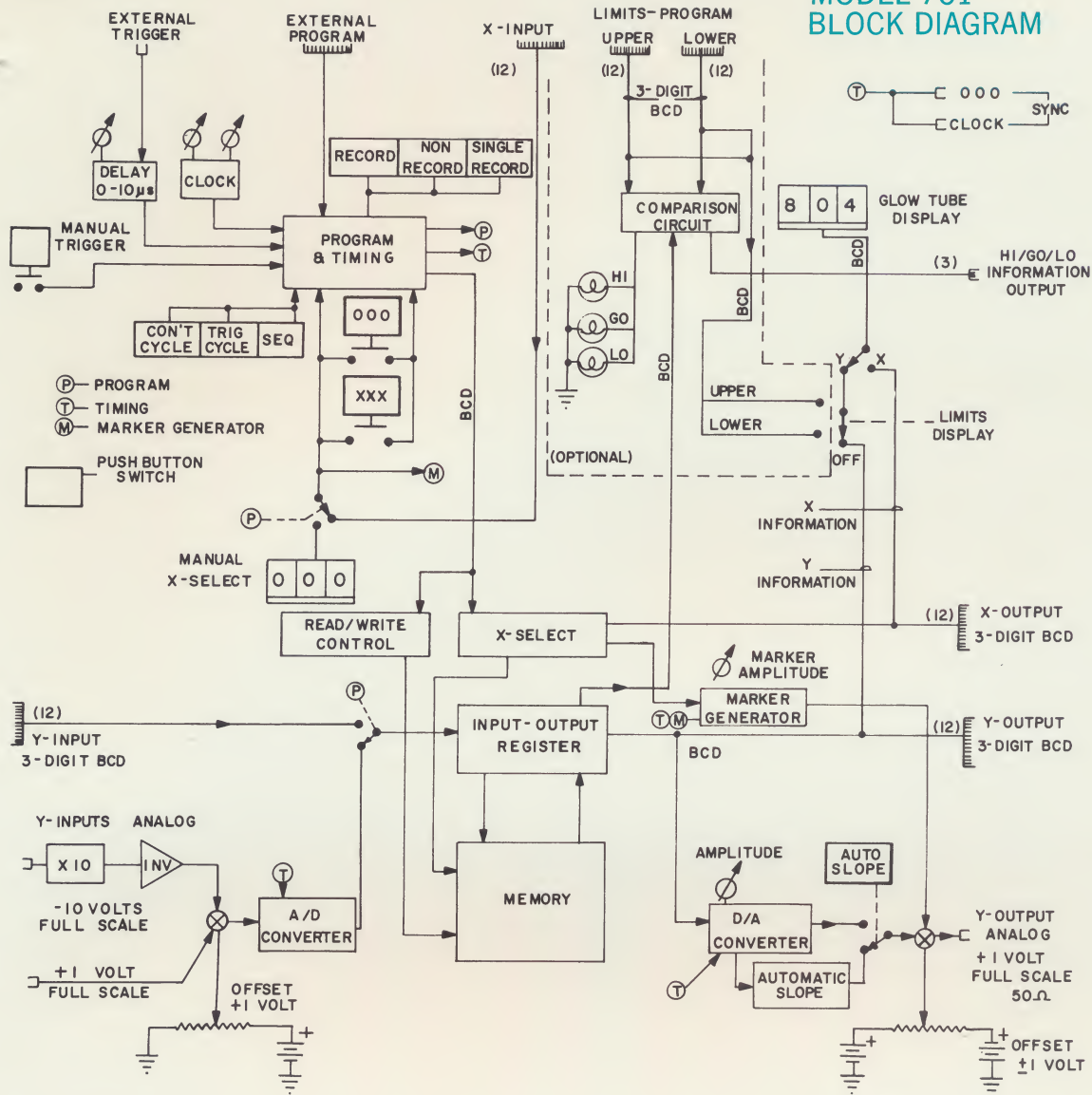


Fig. 4. Output waveform synthesis from the stored digital information. Normal 701 analog output is the stair-step form; pushing the auto-slope button gives a piece-wise linear approximation.

MODEL 701 BLOCK DIAGRAM



PRICES

MODEL 701 (with 1,000-segment x-axis, but without LO/GO/HI indicators or limits comparison capability): \$9,550

MODEL 702 (with 1,000-segment x-axis, plug-in with LO/GO/HI indicators, and limits comparison capability): \$9,950

MODEL 703 (same as Model 701 but with 200-segment x-axis): \$6,850

MODEL 704 (with 200-segment x-axis, plug-in with LO/GO/HI indicators, and limits comparison capability): \$7,250.

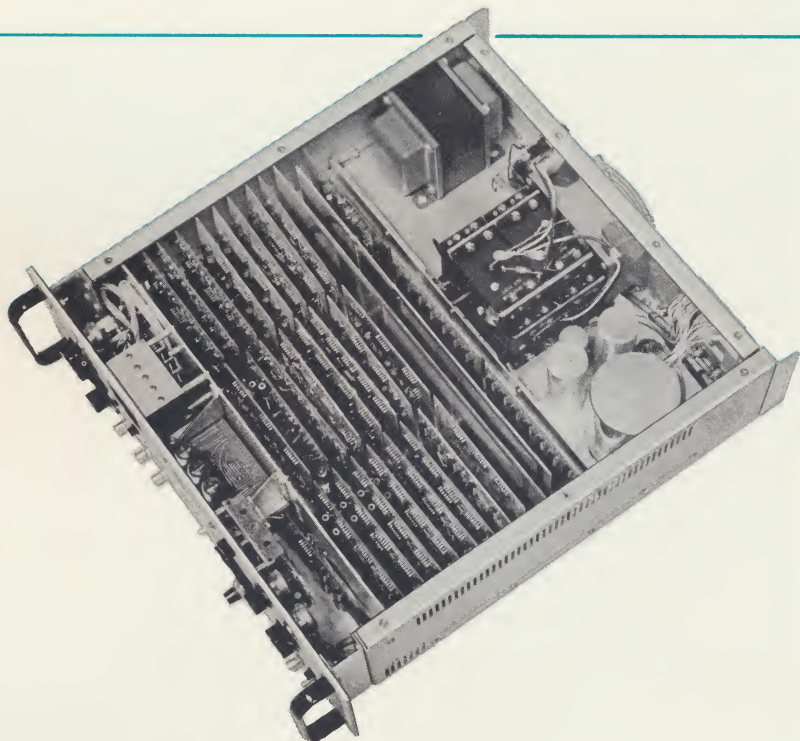


Fig. 1. USING MODEL 701 AT A SWITCHING-TIME MEASUREMENT STATION. Sequence:

(1) Before making t_{on}/t_{off} measurements, collector voltage is delivered to Model 701 analog input for successive inputs of collector-on, collector-off voltages, which are digitized and stored.

(2) Voltage extremes are delivered to normalizing memory for computation of collector swing and generation of 10%/90% discriminator threshold programs, which are used to set Model 142 discriminators.

(3) Successive t_{on} and t_{off} measurements are made by the Model 142 with the 701 analog input switched to receive the data from the 142 output. Information is digitized, compared to programmed GO/NO-GO limits, and stored in the 701 memory along with identifying Measurement No., decimal position, and GO/NO-GO decision.

(4) After measurement sequence is completed, data is delivered to data-handling on command. This example uses only two of the 1000 storage slots of the 701, per measurement.

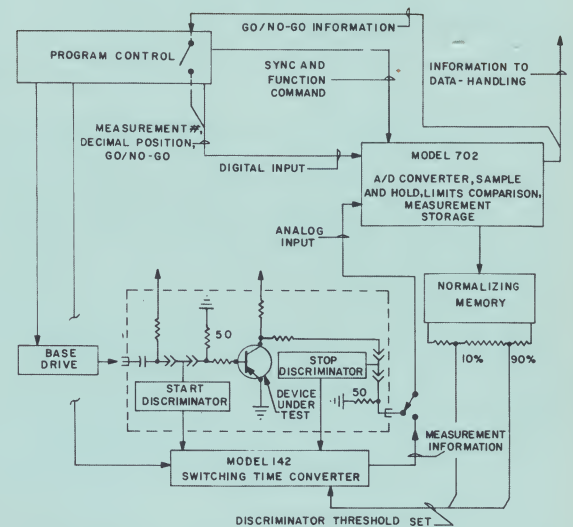


Fig. 2. GENERATING AN ARBITRARY FUNCTION OF VOLTAGE VS. TIME. Sequence:

(1) With the operating mode pushbutton in RECORD, and scanning mode in SEQUENTIAL, push the 000 button to return the scan to t_{000} .

(2) Using a digi-switch to generate BCD-coded ordinates, dial the desired voltage for time t_{000} . Or use the analog input, deriving v_0 from a variable voltage source. Or use the 0 to +1v range of the offset control.

(3) Record v_0 and step the scan to t_1 by pushing the MANUAL trigger button.

(4) Repeat the process for each ordinate. The desired function should be computed for equally-spaced ordinates to the full memory capacity of the 701 (i.e. 200 or 1000 ordinates).

(5) With the function digitized and recorded, it may be played back at any desired rate as a continuous function of time, single-event or iterated. The SINGLE-POINT RECORD mode allows reworking any portion of the recorded function while observing the effect on scope display.

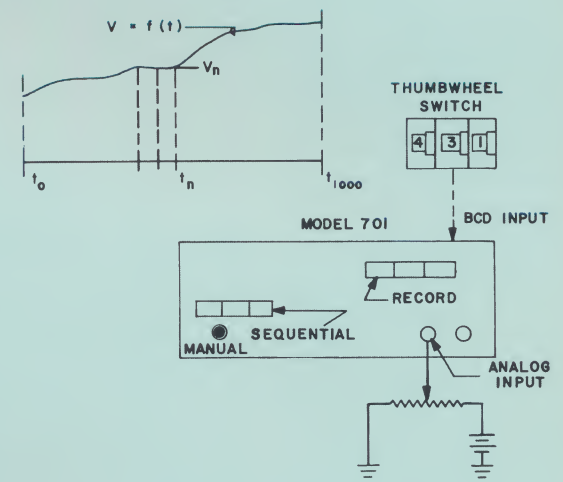


Fig. 3. RECORDING A SINGLE-EVENT TRANSIENT. Sequence:

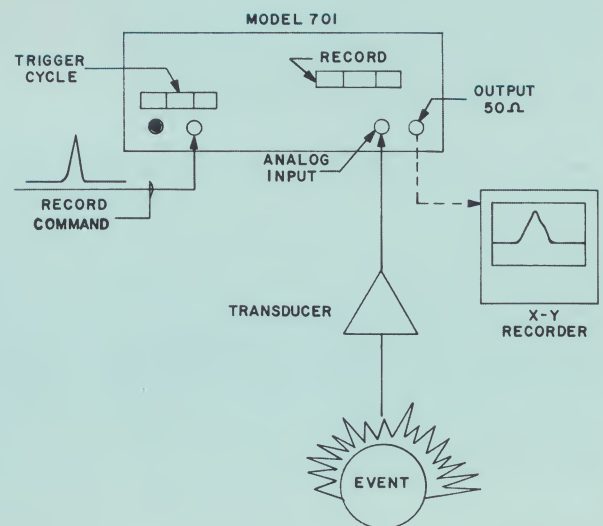
(1) With the operating mode pushbutton in RECORD, and scanning in TRIGGERED CYCLE, push the 000 button to return the scan to t_{000} .

(2) Set the 701 clock rate so that the time span of a complete record cycle will cover the event.

(3) Use a suitable transducer so that the variable to be recorded is converted into a voltage analog suitable for the 701 input.

(4) Trigger the record cycle manually or by system sync pulse. The 701 will scan at the pre-set clock rate, digitize and record the variable presented to its input during one scanning cycle.

(5) The event may now be retained indefinitely in the 701 memory, replayed as often as desired in analog or BCD form, at any time scale within its range. Time scale may be slowed for permanent recording and analysis as shown.



model 701 A-D RECORDER/GENERATOR

X-AXIS (TIME BASE)

RESOLUTION

1000 or 200 slots (option).

SCAN MODES

- **Triggered Cycle**
MANUAL/EXT TRIG pulse initiates single cycle scan at internal clock rate (1 cycle = 1000 steps).
- **Continuous Cycle**
Scanner sweeps and recycles indefinitely at clock rate.
- **Sequential**
MANUAL/EXT TRIG pulse advances scanner one slot, initiates read/write operation as it steps.
- **Manual x-select**
3-digit thumbwheels on front panel select desired x-coordinate. xxx pushbutton moves scanner to setting. 000 pushbutton allows reset to x = 0 at any time.
- **External x-input**
3-digit BCD (3x4 key lines) rear-panel input for remote control of x-scan. Logic levels: > +2.5v = logic "1," <0.2v = logic "0." $Z_{in} \approx 2k$ ohms.

CLOCK AND TRIGGERS

Clock Range: 1 step/sec to 100 kHz in 5 decades with vernier.

Clock Jitter: less than 0.1%.

Ext. Trig Input: +2.5 volts into $\approx 2k$ required.

Trigger Delay: 0 to 10 μs , continuously variable, between EXT TRIG command carry-out.

Trigger outputs: CLOCK, +3.3v, 0.5 μs wide pulse out for every slot step. $Z_{out} \approx 1k$. 000: pulse as above when x-scanner passes initial time slot 000.

X-OUTPUT

x-scanner location is brought out to rear panel in 3-digit BCD form. Logic levels: > +3.3v = logic "1," <0.2v = logic "0." $Z_{out} \approx 1k$.

Y-AXIS (VOLTAGE ORDINATE)

Resolution

1000 counts each ordinate.

Y-INPUTS

Digital input: 3x4 input lines and 12-bit register accept 3-digit BCD info or other 12-bit word at rear-panel connector. Logic levels: > +2.5v = logic "1," <+0.2v = logic "0." $Z_{in} \approx 2k$.

Analog inputs: Basic range 0 to +1v full scale into front and rear BNC's. $Z_{in} \approx 1k$. Rear BNC accepts 0 to -10v full scale for systems applications. $Z_{in} \approx 1k$.

Offset: 0 to +1v range with 10-turn pot and precision-readout dial.

Digitizing time: 10 μs

Note: input register is normally connected to the analog input channel. Program input is required to switch to the direct digital input lines.

Y-OUTPUTS

Digital output: 3 x 4 output lines deliver the contents of the 12-bit register to a rear connector. Ordinate amplitude info from the internal digitizing process is in 3-digit BCD form. Logic levels: +3.3v = logic "1," +0.2v = logic "0." $Z_{out} < 1k$.

Analog output: a waveform constructed from the stored 3-digit ordinate info is delivered to front and rear BNC's. Range: 0 to +1v full scale, continuously variable by AMPLITUDE control. Offset: -1 to +1 volts. Source impedance: 50 ohms. Output form: Normally stair-step approximation, may be switched to auto-slope piecewise-linear form. See fig. 4.

Transient Response:

Digitizing is done by successive approximation during a 10 μs interval. Twelve comparisons are made in sequence, weighted according to BCD code: 800, 400, 200, 100, 80, 40, 20, 10, 8, 4, 2, 1 mv. In operation, any sample presented to the inputs for the entire 10 μs aperture is recorded at maximum attainable accuracy, one part in a thousand. In TRANSIENT RECORD

TRANSIENT RECORD operation, the device will follow any monotonic slope up to its maximum risetime of approximately 2 μs , but with a time shift due to the finite digitizing time.

Accuracy

Any input which is changing slowly during the 10 μs digitizing interval will be recorded to within 0.1%, one part in a thousand. Rapidly-changing inputs will be affected by the digitizing process as described above.

FUNCTIONAL MODES

NON-RECORD: The instrument is in generate or playback mode unless one of the RECORD buttons is in. The NON-RECORD button releases the RECORD switches.

RECORD: Initiating a cycle or step with RECORD button pushed will store whatever is present at the y-input register.

SINGLE-POINT RECORD: Provides access to a single ordinate while displaying a recorded function. This mode allows the operator to modify previously-recorded functions point-by-point. Point selection made by panel digiswitch or by external x-input: panel switch is normal connection. External program controls change-over.

AUXILIARIES

LIMITS COMPARISON (Optional): BCD ordinate information in the input register is compared to upper and lower limits from external sources. LO/GO/HI verdict is displayed on panel lamps and delivered to a rear connector for system use.

MARKER: A spike is delivered to the output analog for easy ordinate location. Positioned by panel digiswitch or by external x-input. Amplitude variable zero to full scale.

CYCLE IN PROGRESS: Panel lamp indicates that x-axis scan is taking place, whether in read or write mode.

GLOW-TUBE DISPLAY: 3-digit panel display indicates location of x-axis scanner or y-ordinate amplitude. Upper or lower limits as they appear at the limits program inputs may be displayed on models having limits-comparison.

PROGRAMMING

PANEL CONTROL OVERRIDE

- RECORD/NON-RECORD/SINGLE-PT. RECORD mode selection
- TRIG CYCLE/CONT CYCLE/SEQ mode selection
- 000/XXX DIGISWITCH/XXX EXT X-INPUT command to x-axis scanner
- AUTO-SLOPE synthesis select
- TRIGGER

ADDITIONAL CONTROL INPUTS

- Switch y-input register from A/D block to BCD input lines
- Inhibit Δx /override "inhibit Δx "
- Inhibit y-input/override "inhibit y-input"
- Switch x-select from digiswitch to BCD x-input
- Hold limits/Hold limits comparison information

CONTROL OUTPUTS

Several lines give process information to the external system:

- Time position 000
- Time position XXX
- x = first of four
- x = second of four
- x = third of four
- x = fourth of four
- ODD time slot
- EVEN time slot
- y > upper limits (optional)
- y within limits (optional)
- y < lower limit (optional)

GENERAL

POWER REQUIREMENT: 105/125 vac, 50/60 Hz, 130 volt-amps (230 vac version no extra cost)

DIMENSIONS: 5 1/4 x 19" panel, 18" deep (276 x 483 x 458 mm)

WEIGHT: 37 lbs. (16.8 kg.) net

Domestic shipping package 45 lbs. (20.5 kg.)

Export package 55 lbs. (25 kg.)



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